CLAIMS LISTING:

CLAIMS

What is claimed is:

1. (original) A frequency-division multiplexed optical communication system comprising:

at least one transmitter configured to receive a number K of data streams and transmit a frequency-division multiplexed optical channel signal comprising a number K subchannels, each subchannel characterized by a subchannel frequency, f_k, k = 1, 2.... K; which is separated from adjacent subchannel frequencies by a constant subchannel frequency spacing, Δf, and each subchannel being modulated by one of the K data streams;

at least one receiver optically connected to the at least one transmitter and configured to receive said frequency-division multiplexed optical channel signal, detect and demodulate said k subchannels within the frequency-division multiplexed optical channel signal;

wherein the K subchannel frequencies are orthogonal to one another and the receiver discriminates among the subchannels by mixing the channel signal with a subchannel light beam from a local subchannel light source, the subchannel light beam having subchannel frequency f_k, to thereby form a mixed optical signal, detecting optical energy of the mixed optical signal, and integrating the mixed optical signal for a single symbol period.

2. (original) The optical communication system of claim 1, wherein each subchannel modulated by one of the k data streams includes two orthogonal polarizations.

3. (original) The optical communication system of claim 2, wherein the receiver is configured to compensate for polarization mode dispersion (PMD).

4. (original) The optical communication system of claim 3, wherein the receiver is configured to digitally rotate digitized electrical signals representative of two orthogonal polarizations of each subchannel to compensate for PMD in said each subchannel.

5. (original) The optical communication system of claim 3, wherein the receiver comprises a PMD compensator device for each subchannel, the PMD compensator device being controlled by a processor associated with the receiver.

6. (original) The optical communication system of claim 1, wherein the transmitter comprises:

at least one light source arranged to output K subchannel light beams, each subchannel light beam being spaced apart from adjacent subchannel light beams by a constant subchannel frequency spacing Δf;

K data modulators, each data modulator configured to modulate one of said

subchannel light beams with data from one of said K data streams to thereby form a subchannel signal; and

a combiner configured to combine K subchannel signals to thereby form an optical channel signal.

7. (original) The optical communication system of claim 6, wherein the transmitter further comprises a frequency calibrator circuit receiving, as input, K subchannel light beams, and outputting at least one control signal to said at least one light source, the frequency calibrator circuit configured to maintain a frequency spacing of 25 Δf between adjacent subchannel light beams.

8. (original) The optical communication system of claim 6, wherein the transmitter further comprises a modulator calibration unit configured to receive at

least one subchannel signal output by a data demodulator and output at least one control signal to said data demodulator.

9. (original) The optical communication system of claim 6, wherein the data modulators each include a polarization beam combiner which encodes data from 5 said data stream on two orthogonal polarizations in said subchannel signal.

10. (original) The optical communication system of claim 9, wherein the data modulator comprises:

splitter circuitry configured to split the subchannel light beam into identical first (H1), second (H2), third (V1) and fourth (V2) component beams;

a first phase shifter configured to impart a 90° phase shift to the second component beam (H2);

a second phase shifter configured to impart a 90° phase shift to the fourth component beam (V2);

a first modulator configured to modulate the first component beam (H1) with first data;

a second modulator configured to modulate the phase-shifted second component beam (H2) with second data;

a third modulator configured to modulate the third component beam (V1) with third data;

a fourth modulator configured to modulate the phase-shifted fourth component beam (V2) with fourth data;

a first combiner (840a) configured to combine the data-modulated first component beam (H1) with the data-modulated and phase-shifted second component beam (H2), and output a first data-modulated beam (H');

a second combiner (840b) configured to combine the data-modulated third component beam (V1) with the data-modulated and phase-shifted fourth component beam (V2), and output a second data-modulated beam (V'); and

a polarization beam combiner (850) configured to combine the first and second data-modulated beams and output a subchannel signal (342) having two orthogonal polarizations.

11. (original) The optical communication system of claim 6, wherein the at least one light source comprises a single frequency comb generator configured to output the K subchannel light beams.

12. (original) The optical communication system of claim 11, wherein the transmitter further comprises:

a pulse shaper circuit configured to shape at least one of the subchannel light beams prior to modulation by the data modulator.

13. (original) The optical communication system of claim 6, wherein the transmitter further comprises:

a pulse shaper circuit configured to shape at least one of the subchannel light beams prior to modulation by the data modulator.

14. (original) The optical communication system of claim 1, wherein the receiver comprises:

an optical splitter having a splitter input and a plurality of splitter outputs, the optical splitter configured to receive an optical channel signal comprising K subchannel signals, and output K identical received channel signals;

a number K subchannel receivers, the k^{th} subchannel receiver comprising optical and digital circuitry configured to receive the k^{th} of said K identical received channel signals and a reference light beam having a subchannel frequency f_k, and output a first digital signal representative of in-phase and quadrature components of a first orthogonal polarization component associated with subchannel frequency f_k, and also output a second digital signal representative of in-phase and quadrature components of a second orthogonal

polarization component associated with subchannel frequency f_k, the first and second digital signals containing information representative of the data stream that was used to modulate the k^{th} subchannel signal; and

a receiver processor configured to receive said first and second digital signals and output one of said K data streams.

15. (original) The optical communication system of claim 14, wherein the receiver further comprises:

a frequency calibration circuit configured to calibrate at least one light source to thereby maintain a frequency spacing of Δf between K adjacent subchannel light beams, the frequency calibration circuit receiving, as input, at least K subchannel light beams each characterized by a subchannel frequency f_k and outputting at least one frequency calibration control signal applied to at least one light source creating at least one of said K subchannel light beams.

16. (original) The optical communication system of claim 15, wherein the frequency calibration circuit comprises:

a first optical switch configured to select from among (a) said K subchannel light beams and (b) a reference light beam, to thereby output a selected beam;

an optical splitter configured to split the selected signal to first and second selected split beams;

an optical delay configured to receive the first selected split beam as input, delay the first selected split beam by a predetermined time delay T, and output a delayed first selected split beam;

an optical detector configured to receive the delayed first selected split beam and the second selected split beam, and output a digitized electrical signal that is proportional to $e^{j\omega}$, where ω co is the frequency of the selected beam;

a controller configure to receive the digitized electrical signal and output said at least one frequency calibration control signal.

17. (original) The optical communication system of claim 14, wherein each subchannel receiver comprises:

a polarization beam splitter configured to receive one of said K identical receiver channel signals as input, and split said one of said K identical receiver channel signals into first and second orthogonal polarization components;

a first optical phase detector configured to receive the first orthogonal polarization component and a subchannel light beam having a subchannel frequency f_k as inputs, and output said first digital signal;

a second optical phase detector configured to receive the second orthogonal polarization component and said subchannel light beam having a subchannel frequency f_k as inputs, and output said second digital signal, and wherein the first and second digital signals are input to said receiver processor.

18. (original) The optical communication system of claim 17, wherein each subchannel receiver further comprises:

a first variable optical delay configured to selectively delay the first orthogonal polarization component before it is input to the first optical phase detector;

a second variable optical delay configured to selectively delay the second orthogonal polarization component before it is input to the second optical phase detector,

wherein the first and second variable optical delays are controlled by said receiver processor.

19. (original) The optical communication system of claim 17, wherein each optical phase detector includes first and second integrate and dump filters configured to integrate detected analog respective in-phase and quadrature signals for an integrating period that is less than a symbol period to thereby produce respective detected analog in-phase and quadrature subchannel signals corresponding to said subchannel frequency f_k.

20. (original) The optical communication system of claim 14, wherein the receiver processor comprises:

a polarization mode dispersion (PMD) compensation control module configured to digitally compensate the first and second digital signals to thereby produce PMD-compensated first and second digital signals;

a synchronization and symbol timing module configured to produce optical detector control signals including at least one clock signal for controlling the subchannel receiver, based on at least one of the first and second digital signals and the first and second PMD-compensated digital signals; and

a data demodulation module configured to output the data stream that was used to modulate the k^{th} subchannel, based on the first and second PMD-compensated digital signals.

21. (original) The optical communication system of claim 20, wherein the synchronization and symbol timing module includes a Stokes-based timing error detector module.

22. (original) The optical communication system of claim 20, wherein the synchronization and symbol timing module also includes a Mueller & Muller timing error detector module, and wherein the Stokes-based timing error detector module is invoked first and the Muller and Muller timing error detector module is invoked thereafter.

23. (original) The optical communication system of claim 20, wherein the PMD compensation control module is configured to execute an iterative search procedure to find optimum coefficients of a rotation matrix for rotating the first and second digital signals to thereby create the PMD-compensated first and second digital signals.

24. (original) The optical communication system of claim 23, wherein, during each iteration, the search procedure calculates at least one metric for each of a plurality of candidate pairs of rotation angles, and selects the candidate pair of rotation angles corresponding to an optimization criterion for said at least one metric, to thereby calculate the coefficients of said rotation matrix, the iterations continuing until a terminating condition is met.

25. (original) The optical communication system of claim 24, wherein a step size of the candidate pairs of rotation angles is adjusted at each iteration.

26. (original) The optical communication system of claim 14, wherein each subchannel receiver comprises:

a polarization mode dispersion (PMD) compensator device configured to receive one of said K identical receiver channel signals as input and output a PMD compensated version of said one of said K identical receiver channel signals, the PMD compensator device being controlled by at least one PMD device control signal from the receiver processor;

a polarization beam splitter configured to receive said PMD-compensated version of said one of said K identical receiver channel signals as input, and split said PMD-compensated version of said one of said K identical receiver channel signals into first and second orthogonal polarization components;

a first optical phase detector configured to receive the first orthogonal polarization component and a subchannel light beam having a subchannel frequency f_k as inputs, and output said first digital signal;

a second optical phase detector configured to receive the second orthogonal polarization component and said subchannel light beam having a subchannel frequency f_k as inputs, and output said second digital signal, and wherein the first and second digital signals are input to said receiver processor

27. (original) The optical communication system of claim 26, wherein each subchannel receiver further comprises:

a first variable optical delay configured to selectively delay the first orthogonal polarization component before it is input to the first optical phase detector;

a second variable optical delay configured to selectively delay the second orthogonal polarization component before it is input to the second optical phase detector,

wherein the first and second variable optical delays are controlled by said receiver processor.

28. (original) The optical communication system of claim 26, wherein each optical phase detector includes first and second integrate and dump filters configured to integrate detected analog respective in-phase and quadrature signals for an integrating period that is less than a symbol period to thereby produce respective detected analog in-phase and quadrature subchannel signals corresponding to said subchannel frequency f_k.

29. (original) The optical communication system of claim 26, wherein the receiver processor comprises:

a polarization mode dispersion (PMD) compensation control module configured to output the at least one PMD device control signal, based on the first and second digital signals;

a synchronization and symbol timing module configured to produce optica detector control signals including at least one clock signal for controlling the subchannel receiver, based on said first and second digital signals; and

a data demodulation module configured to output the data stream that was used to modulate the k^{th} subchannel, based on the first and second digital signals.

30. (original) The optical communication system of claim 29, wherein the synchronization and symbol timing module includes Mueller& Muller timing error detector module.

31. (original) The optical communication system of claim 29, wherein the PMD compensation control module is configured to execute an iterative search procedure to find optimum rotation angles for producing the PMD device control signals

32. (original) The optical communication system of claim 31, wherein, during each iteration, the search procedure determines a candidate pair of rotation angles, calculates said at least one metric for said candidate pair of rotation angles, stores the metric, and produces said at least one PMD device control signal that is applied to the PMD compensator device, for each candidate pair of rotation angles.

33. (original) The optical communication system of claim 32, wherein a step size governing selection of the candidate pairs of rotation angles is adjusted at each iteration.

34. (original) The optical communication system of claim 1, wherein the receiver comprises:

an optical demultiplexer having an input and a plurality of outputs, the optic demultiplexer configured to receive an optical channel signal comprising K subchannel signals, and output K different received channel signals;

a number K self-homodyne subchannel receivers, the k^{th} subchannel receiver comprising optical and digital circuitry configured to receive a k^{th} of said K different received channel signals and output a first digital signal representative of in-phase and quadrature components of a first orthogonal polarization component associated with subchannel frequency f_k, and also output a second

digital signal representative of in-phase and quadrature components of a second orthogonal polarization component associated with subchannel frequency f_k, the first and second digital signals containing information representative of the data stream that was used to modulate the k^{th} subchannel signal; and

a receiver processor configured to receive said first and second digital signals and output the k^{th} data stream.

35. (original) The optical communication system of claim 34, wherein the k^{th} self homodyne subchannel receiver comprises:

a polarization mode dispersion (PMD) compensator device configured to receive said k^{th} received channel signal as input and output a PMD-compensated k^{th} received channel signal, the PMD compensator device being controlled by at least one PMD device control signal from the receiver processor;

a polarization beam splitter configured to receive and split said PMD compensated k^{th} received channel signal into first and second orthogonal polarization components;

a first polarization sensitive optical detector configured to receive the first orthogonal polarization component as a first input and a delayed version of the first orthogonal polarization component as a second input, and output said first digital signal; and

a second polarization sensitive optical detector configured to receive the second orthogonal polarization component as a first input and a delayed version of the second orthogonal polarization component as a second input, and output said second digital signal.

36. (original) The optical communication system of claim 35, wherein the delayed versions of the first and second orthogonal polarization components are each delayed by one symbol period.

37. (original) The optical communication system of claim 34, wherein the k^{th} self homodyne subchannel receiver comprises:

a polarization mode dispersion (PMD) compensator device configured to receive said k^{th} received channel signal as input and output a PMD-compensated received channel signal, the PMD compensator device being controlled by at least one PMD device control signal from the receiver processor;

a polarization sensitive optical hybrid circuit configured to receive the PMD compensated k^{th} received channel signal as a first input and a delayed version of the PMD-compensated k^{th} received channel signal as a second input, and output first, second, third and fourth combined signals;

first, second, third and fourth polarization beam splitters configured to receive corresponding first, second, third and fourth combined signals as input, and output respective first, second, third and fourth pairs of first and second orthogonal polarization components;

a first matched detector configured to receive the first orthogonal component output by each of the first and second polarization beam splitters, and output a first analog electrical detection signal;

a second matched detector configured to receive the first orthogonal component output by each of the third and fourth polarization beam splitters, and output a second analog electrical detection signal;

a third matched detector configured to receive the second orthogonal component output by each of the first and second polarization beam splitters, and output a third analog electrical detection signal;

a fourth matched detector configured to receive the second orthogonal component output by each of the third and fourth polarization beam splitters, and output a fourth analog electrical detection signal;

a first circuit configured to receive said first and second analog electrical detection signals and output said first digital signal; and

a second circuit configured to receive said third and fourth analog electrical detection signals and output said second digital signal.

38. (original) The optical communication system of claim 37, wherein the delayed version of the PMD-compensated k^{th} received channel signal is delayed by one symbol period.

39. (original) The optical communication system of claim 34, wherein the k^{th} self homodyne subchannel receiver comprises:

an optical hybrid circuit configured to receive the k^{th} received channel signal as a first input and a delayed version of the k^{th} received channel signal as a second input, and output first, second, third and fourth combined signals;

first, second, third and fourth polarization mode dispersion (PMD) compensator devices configured to receive the first, second, third and fourth combined signals, respectively, and output corresponding PMD-compensated first, second, third and fourth combined signals, respectively; each of the PMD compensator devices being controlled by at least one PMD device control signal from the receiver processor;

first, second, third and fourth polarization beam splitters configured to receive corresponding first, second, third and fourth PMD-compensated combined signals as input, and output respective first, second, third and fourth pairs of first and second orthogonal polarization components;

a first matched detector configured to receive the first orthogonal component output by each of the first and second polarization beam splitters, and output a first analog electrical detection signal;

a second matched detector configured to receive the first orthogonal component output by each of the third and fourth polarization beam splitters, and output a second analog electrical detection signal;

a third matched detector configured to receive the second orthogonal component output by each of the first and second polarization beam splitters, and output a third analog electrical detection signal;

a fourth matched detector configured to receive the second orthogonal component output by each of the third and fourth polarization beam splitters, and output a fourth analog electrical detection signal;

a first circuit configured to receive said first and second analog electrical detection signals and output said first digital signal; and

a second circuit configured to receive said third and fourth analog electrical detection signals and output said second digital signal.

40. (original) The optical communication system of claim 39, wherein the delayed version of the k^{th} received channel signal is delayed by one symbol period.

41. (original) An optical communication transmitter comprising:

at least one light source arranged to output a number K subchannel light beams, each subchannel light beam being spaced apart from adjacent subchannel light beams by a constant subchannel frequency spacing Δf;

K data modulators, each data modulator configured to modulate one of said subchannel light beams with data from a data stream to thereby form a subchannel signal, each data modulator including a polarization beam combiner which encodes data from said data stream on two orthogonal polarizations in said subchannel signal; and

a combiner configured to combine K subchannel signals to thereby form an optical channel signal.

42. (original) The optical communication transmitter of claim 41, wherein the transmitter further comprises a frequency calibrator circuit receiving, as input, K subchannel light beams, and outputting at least one control signal to said at least one light source, the frequency calibrator circuit configured to maintain a frequency spacing of Δf between adjacent subchannel light beams.

43. (original) The optical communication transmitter of claim 41, wherein the transmitter further comprises a modulator calibration unit configured to receive at least one subchannel signal output by a data demodulator and output at least one control signal to said data demodulator.

44. (original) The optical communication transmitter of claim 41, wherein the at least one light source comprises a single frequency comb generator configured to output the K subchannel light beams.

45. (original) The optical communication transmitter of claim 41, wherein the transmitter further comprises:

a pulse shaper circuit configured to shape at least one of the subchannel light beams prior to modulation by the data modulator.

46. (original) An optical communication receiver comprising:

An optical splitter having a splitter input and a plurality of splitter outputs, the optical splitter configured to receive an optical channel signal comprising a number K subchannel signals, and output K identical received channel signals;

K subchannel receivers, the e subchannel receiver comprising optical and digital circuitry configured to receive the k^{th} of said K identical received channel signals and a reference light beam having a subchannel frequency f_k, and output a first digital signal representative of in-phase and quadrature components of a first orthogonal polarization component associated with the subchannel frequency f_k, and also output a second digital signal representative of in-phase and quadrature components of a second orthogonal polarization component associated with the subchannel frequency f_k, the first and second digital signals containing information representative of a data stream used to modulate the k^{th} subchannel frequency; and

a receiver processor configured to receive said first and second digital signals and output said data stream.

47. (original) The optical communication receiver of claim 46, wherein the receiver further comprises:

a frequency calibration circuit configured to calibrate at least one light source to thereby maintain a frequency spacing of Δf between K adjacent subchannel light beams, the frequency calibration circuit receiving, as input, at least K subchannel light beams each characterized by a subchannel frequency f_k and outputting at least one frequency calibration control signal applied to at least one light source creating at least one of said K subchannel light beams.

48. (original) The optical communication receiver of claim 47, wherein the frequency calibration circuit comprises:

a first optical switch configured to select from among (a) said K subchannel light beams and (b) a reference light beam, to thereby output a selected beam;

an optical splitter configured to split the selected signal to first and second selected split beams;

an optical delay configured to receive the first selected split beam as input, delay the first selected split beam by a predetermined time delay T, and output a delayed first selected split beam;

an optical detector configured to receive the delayed first selected split beam and the second selected split beam, and output a digitized electrical signal that is proportional to $e^{j\omega T}$, where ω is the frequency of the selected beam;

a controller configure to receive the digitized electrical signal and output said at least one frequency calibration control signal.

49. (original) The optical communication receiver of claim 46, wherein the k^{th} subchannel receiver comprises:

a polarization beam splitter configured to receive and split the k^{th} of said K identical receiver channel signals into first and second orthogonal polarization components;

a first optical phase detector configured to receive the first orthogonal polarization component and the reference light beam having a subchannel frequency f_k as inputs, and output said first digital signal;

a second optical phase detector configured to receive the second orthogonal polarization component and the reference light beam having a subchannel frequency f_k as inputs, and output said second digital signal, and wherein

the first and second digital signals are input to said receiver processor.

50. (original) The optical communication receiver of claim 49, wherein the k^{th} subchannel receiver further comprises:

a first variable optical delay configured to selectively delay the first orthogonal polarization component before it is input to the first optical phase detector;

a second variable optical delay configured to selectively delay the second orthogonal polarization component before it is input to the second optical phase detector,

wherein the first and second variable optical delays are controlled by said receiver processor.

51. (original) The optical communication receiver of claim 49, wherein each optical phase detector includes first and second integrate and dump filters configured to integrate detected analog respective in-phase and quadrature signals for an integrating period that is less than a symbol period to thereby produce respective detected analog in-phase and quadrature subchannel signals corresponding to said subchannel frequency f_k.

52. (original) The optical communication receiver of claim 46, wherein the receiver processor comprises:

a polarization mode dispersion (PMD) compensation control module configured to digitally compensate the first and second digital signals to thereby produce PMD-compensated first and second digital signals;

a synchronization and symbol timing module configured to produce optical detector control signals including at least one clock signal for controlling the subchannel receiver, based on at least one of the first and second digital signals and the first and second PMD-compensated digital signals; and

a data demodulation module configured to output the data stream that was used to modulate at least one of said K subchannels, based on the first and second PMD-compensated digital signals.

53. (original) The optical communication receiver of claim 52, wherein the synchronization and symbol timing module includes a Stokes-based timing error detector module.

54. (original) The optical communication receiver of claim 52, wherein the synchronization and symbol timing module also includes a Mueller & Muller timing error detector module, and wherein the Stokes-based timing error detector module is invoked first and the Muller and Muller timing error detector module is invoked thereafter.

55. (original) The optical communication receiver of claim 52, wherein the PMD compensation control module is configured to execute an iterative search procedure to find optimum coefficients of a rotation matrix for rotating the first and second digital signals to thereby create the PMD-compensated first and second digital signals.

56. (original) The optical communication receiver of claim 55, wherein, during each iteration, the search procedure calculates at least one metric for each of a plurality of candidate pairs of rotation angles, and selects the candidate

pair of rotation angles corresponding to an optimization criterion for said at least one metric, to thereby calculate the coefficients of said rotation matrix, the iterations continuing 5 until a terminating condition is met.

57. (original) The optical communication receiver of claim 56, wherein a step size of the candidate pairs of rotation angles is adjusted at each iteration.

58. (original) The optical communication receiver of claim 52, wherein the receiver processor further comprises a frequency offset compensator.

59. (original) The optical communication receiver of claim 46, wherein the subchannel receiver comprises:

a polarization mode dispersion (PMD) compensator device configured to receive the k^{th} of said K identical receiver channel signals as input and output a PMD-compensated version of said k^{th} identical receiver channel signals, the PMD compensator device being controlled by at least one PMD device control signal from the receiver processor;

a polarization beam splitter configured to receive and split said PMD compensated version of said e identical receiver channel signal into first and second orthogonal polarization components;

a first optical phase detector configured to receive the first orthogonal polarization component and the reference light beam having a subchannel frequency f_k as inputs, and output said first digital signal;

a second optical phase detector configured to receive the second orthogonal polarization component and the reference light beam having a subchannel frequency f_k as inputs, and output said second digital signal, and wherein

the first and second digital signals are input to said receiver processor.

60. (original) The optical communication receiver of claim 59, wherein the subchannel receiver further comprises:

a first variable optical delay configured to selectively delay the first orthogonal polarization component before it is input to the first optical phase detector;

a second variable optical delay configured to selectively delay the second orthogonal polarization component before it is input to the second optical phase detector,

wherein the first and second variable optical delays are controlled by said receiver processor.

61. (original) The optical communication receiver of claim 59, wherein each optical phase detector includes first and second integrate and dump filters configured to integrate detected analog respective in-phase and quadrature signals for an integrating period that is less than a symbol period to thereby produce respective detected analog in-phase and quadrature subchannel signals corresponding to said subchannel frequency f_k.

62. (original) The optical communication receiver of claim 59, wherein the receiver processor comprises:

a polarization mode dispersion (PMD) compensation control module configured to produce said at least one PMD device control signal, based on the first and second digital signals;

a synchronization and symbol timing module configured to produce optical detector control signals including at least one clock signal for controlling the subchannel receiver, based on said first and second digital signals; and

a data demodulation module configured to output the data stream that was used to modulate the k^{th} subchannel, based on the first and second digital signals.

63. (original) The optical communication receiver of claim 62, wherein the synchronization and symbol timing module includes Mueller & Muller timing error detector module.

64. (original) The optical communication receiver of claim 62, wherein the PMD compensation control module is configured to execute an iterative search procedure to find optimum rotation angles for producing the PMD device control signals.

65. (original) The optical communication receiver of claim 64, wherein, during each iteration, the search procedure determines a candidate pair of rotation angles, calculates said at least one metric for said candidate pair of rotation angles, stores the metric, and produces said at least one PMD device control signal that is applied to the PMD compensator device, for each candidate pair of rotation angles.

66. (original) The optical communication receiver of claim 65, wherein a step size governing selection of the candidate pairs of rotation angles is adjusted at each iteration.

67. (original) The optical communication receiver of claim 62, wherein the receiver processor further comprises a frequency offset compensator.

68. – 74. (cancelled).

75. (original) A frequency calibration system for calibrating a number K of laser light beams, each laser light beam having a frequency f_k, k= 1, 2, 3, . . ., K, the frequency calibration system comprising:

an optical switch system configured to select one from among the K laser light beams and a reference beam and output a selected beam;

a splitter disposed to receive the selected beam and output first identical first and second selected beams;

an optical detector configured to receive a delayed version of the first selected beam and the second selected beam, and output at least one electrical signal proportional to a phase difference between the two beams;

a controller configured to receive said at least one electrical signal and output at least one frequency calibration control signal to control at least one light source responsible for creating at least one of said plurality of laser light beams.

76. (original) The frequency calibration system of claim 75, wherein the optical switch system comprises a K:1 switch configured to select one from among said K light beams and a 2:1 switch configured a select from among the reference light beam and said one from among said K light beams to thereby output said selected beam.

77. (original) The frequency calibration system of claim 75, wherein the first selected 5 beam is delayed by one symbol period.

78. (original) An iterative method for compensating for polarization mode dispersion (PMD) in an optical signal comprising:

(a) determining a candidate pair of rotation angles for adjusting a state of polarization of the optical signal;

(b) calculating at least one metric for said candidate pair of rotation angles

(c) storing the at least one metric and also outputting at least one PMD device control signal that is applied to a PMD compensator device into which the optical signal is input;

(d) repeating steps (a), (b) and (c) until metrics; for a predetermined set of candidate pairs have been calculated;

(e) finding the optimum metric and the optimum rotation angles corresponding to that metric; and

(f) outputting at least one PMD device control signal which corresponds to the optimum angles, to said PMD compensator device into which the optical signal is input.

79. (original) The method according to claim 78, wherein the metric is an envelope stability metric.

80. (original) The method according to claim 78, further comprising repeating steps (a) -(f) until a predetermined condition is met, and wherein a step size for the candidate pairs of rotation angles is adjusted at each iteration of steps (a)-(f).

81. (original) A method for compensating for polarization mode dispersion (PMD) in an optical signal having two orthogonal polarizations, the method comprising:

(a) determining a candidate pair of rotation angles for adjusting a state of polarization of the optical signal;

(b) calculating at least one metric for said candidate pair of rotation angles;

(c) storing the metric;

(d) performing steps (a), (b) and (c) until metrics for a predetermined set of candidate pairs have been calculated;

(e) finding the optimum metric and the optimum rotation angles corresponding to that metric, and then updating a rotation matrix having coefficients derived from the optimum rotation angles;

(f) digitally compensating for PMD by applying the rotation matrix to digitized signals representing the information set on the two orthogonal polarizations.

82. (original) The method according to claim 81, wherein the metric is an envelope stability metric.

83. (original) The method according to claim 81, further comprising, before step (f), 20 repeating steps (a) -(e) until a predetermined condition is met.

84. (original) The method according to claim 83, further comprising adjusting a step size for the candidate pairs of rotation angles at each iteration of steps (a)-(e).

85. (original) A method for symbol time recovery from an optical signal having two orthogonal polarizations and comprising symbols characterized by a symbol period, the method comprising the steps of:

(a) separating the optical signal into a first digital signal having a first polarization and a second digital signal having a second polarization;

(b) calculating a Stokes-parameter based discriminator function based on the first and second digital signals; and

(c) estimating a timing error signal τ_ε, from the Stokes-parameter based discriminator function.

86. (original) The method according to claim 85, wherein the discriminator function is formed from an inner product of Stokes vectors derived from the first and second digital signals.

87. (original) The method according to claim 86, wherein the discriminator function is given by:

$$DF(\tau) = 1 - \_\_\_\_\_\_(S[p]^{\cdot}\ S[p+1]) \qquad (24)$$

where:

τ is the normalized timing error;

P is a predetermined number of Stokes vectors used to calculate the discriminator function; and

the inner product of the two Stokes vectors S[p] and S[p+l] is given by

$S[p]^{*} S[p+1] = s_1[p]\, s$______________;

with:

$S[p] = (s_1[p], s_2[p], s_2[p])$;

$s_1[p] = (v[p]v[p]^* - h[p]h[p]^*)/ s_o[p]$

$s_2[p] = 2\,\mathrm{Re}\,(v[p]h[p]^*)/ s_o[p]$

$s_3[p] = 2\,\mathrm{Im}(v[p]h[p]^*) / s_o[p]$

$s_o[p] = (v[p]v[p]^* + h[p]h[p]^*)/s_o[p]$;

v[p] is the first digital signal; and

h[p] is the second digital signal with 'p' being a symbol index.